SWTEST ASIA

PROBE TODAY, FOR TOMORROW

ACCOMPLISHING TRUE KNOWN GOOD DIE VERIFICATION TESTING IN WAFER TEST

TEL TOKYO ELECTRON

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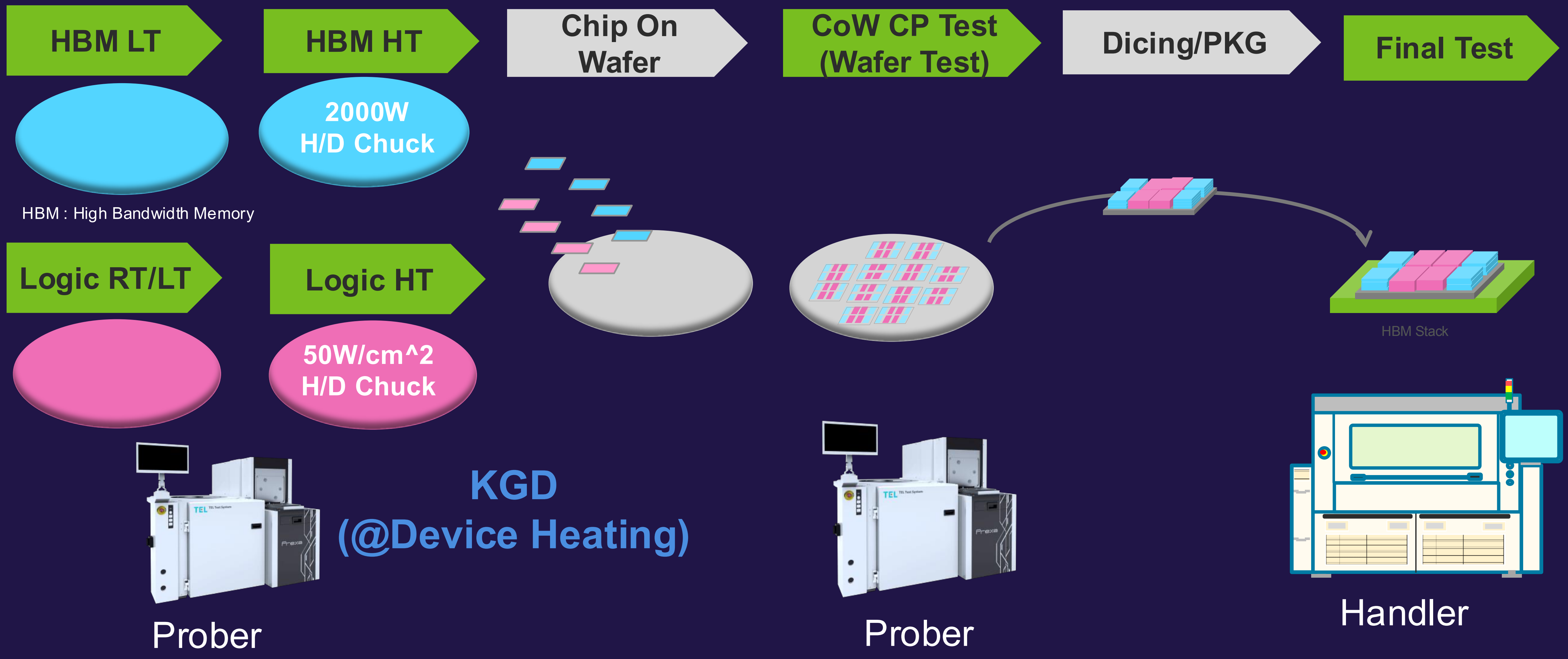
Source: TEL

Test Trend for Advanced Package

KGD: Known Good Die



Require True Known Good Die verification testing in WAFER TEST for saving cost.
Prober needs active thermal control (ATC) solution to enable KGD in wafer test.

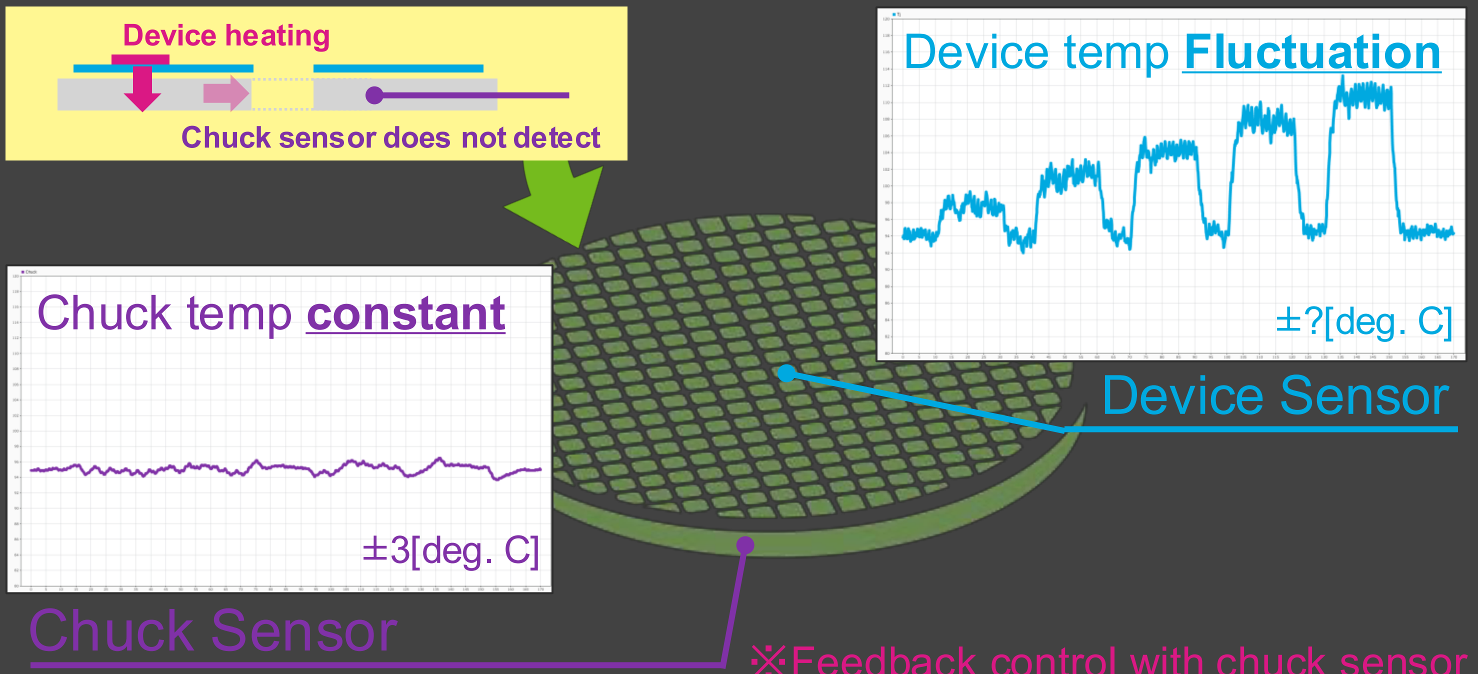
Agenda

- Background : The challenges of Device Temperature Control +/-3℃ in Prober
- Objectives : Maintain constant device temperature
- New Technology for Active Thermal Control System (ATCS)
  - Item 1 : Tester IF Board
  - Item 2 : Advanced Chuck
  - Item 3 : Model-based controller design
- Key Data
  - Evaluation Fixture and Thermal Control Mode
  - Results of Active Thermal Control and Tj Simulation
- Conclusion

Background :
The challenges of Device Temperature Control +/-3℃ in Prober

- Unable to Device Temperature Control
  - – Conventionally maintain constant chuck temperature

Chuck temperature control (conventional)



※Feedback control with chuck sensor

Future Trends

Active Thermal Control

DTF Control
（Feedback on device temperature）

Advanced Chuck
（50[W/cm2] or more heat absorption）

TEL is up for the challenge

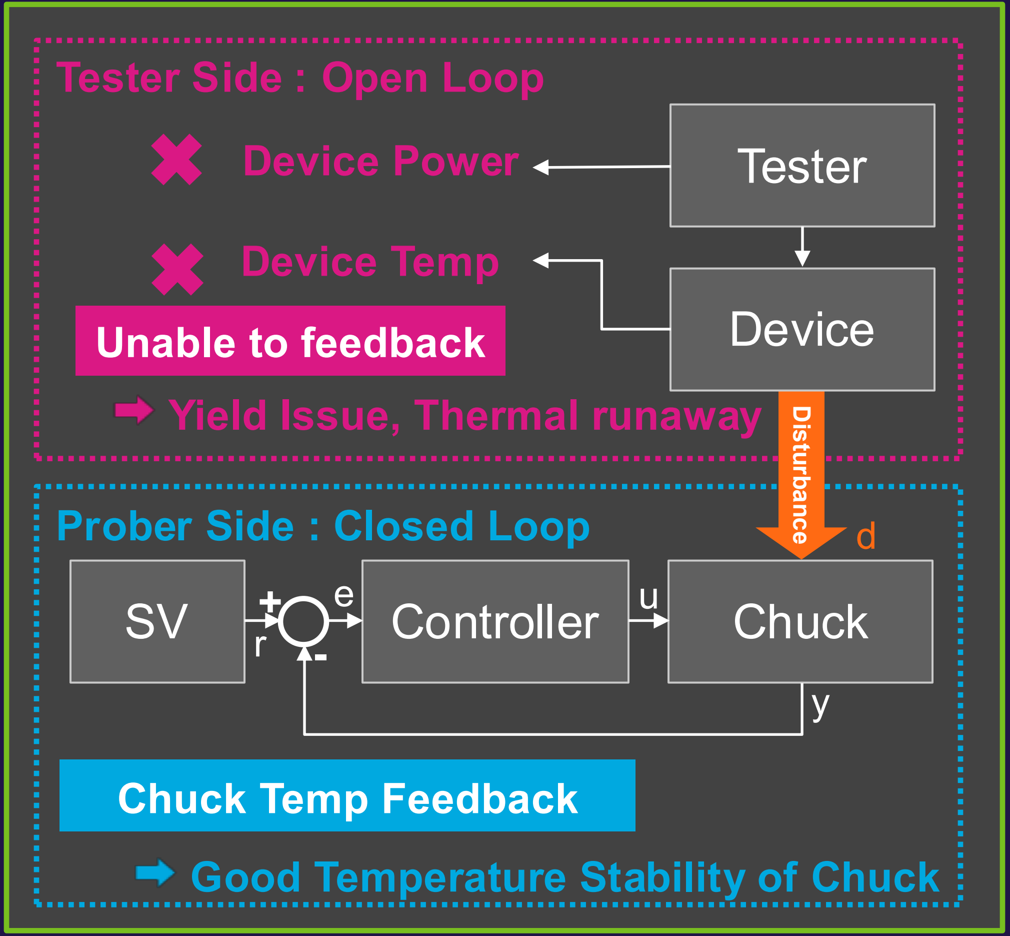
Thermal resistance exists between the device and the chuck sensor.

Device temperature control is required

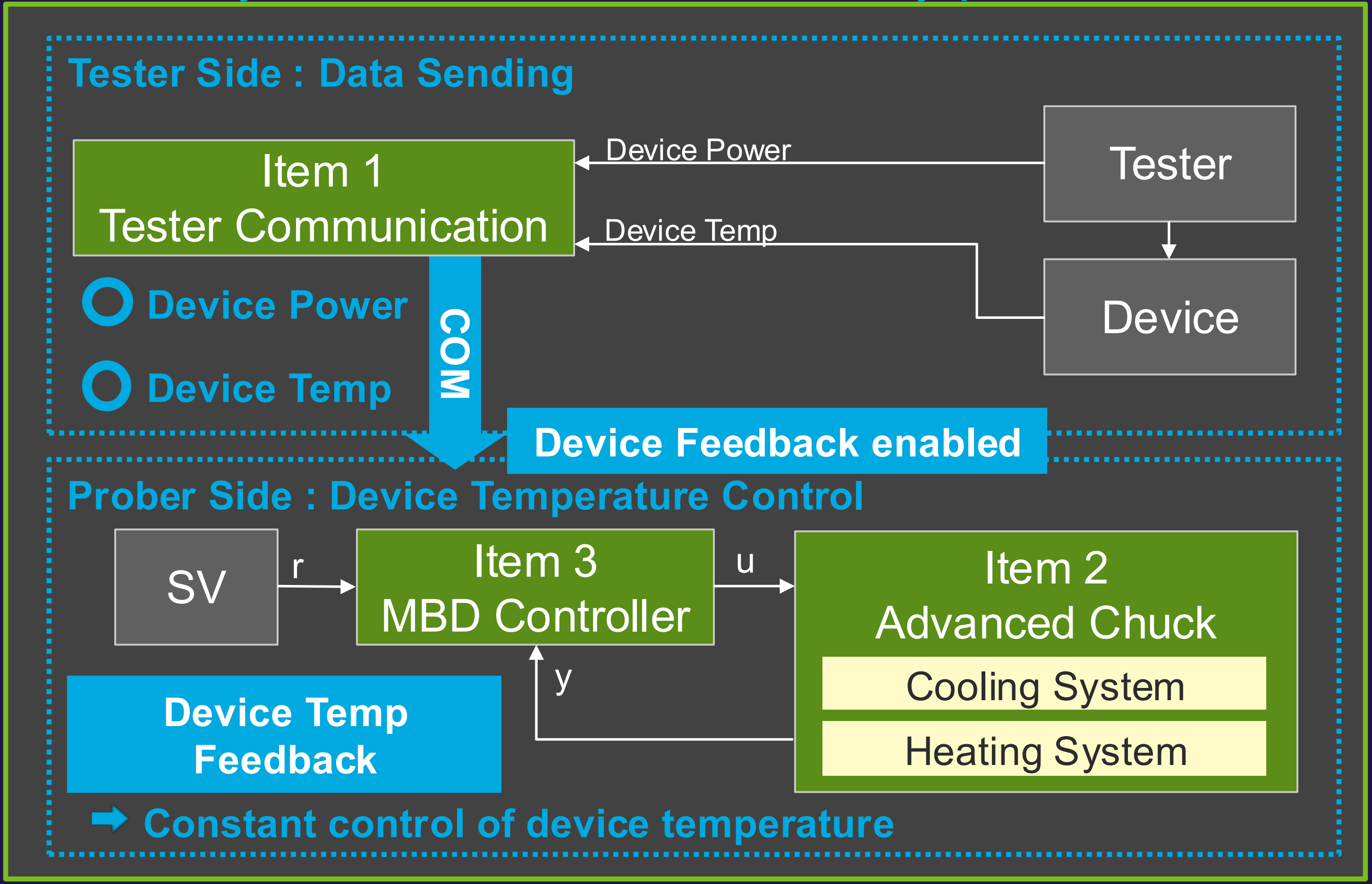
Objectives : Maintain constant device temperature

- Review of control method

Conventional Control



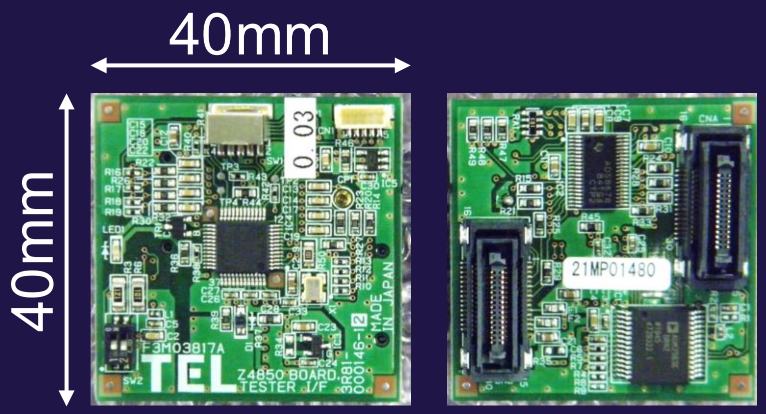
Control system to be realized and key points



Prober can actively control chuck temperature

New Technology : Tester IF Board

- How to get data from a device
  - <u>**Tester IF Board**</u>



Top　　Bottom

Item	Tester IF Board
Supported Tester	UFP, V93K and more
Tj Signal Type	- Analog Voltage - Digital Packet - Thermal Diode **Max 32CH**
Device Power Feedback	**Enable**

Tester I/F Board
- Send Device Temp and Power

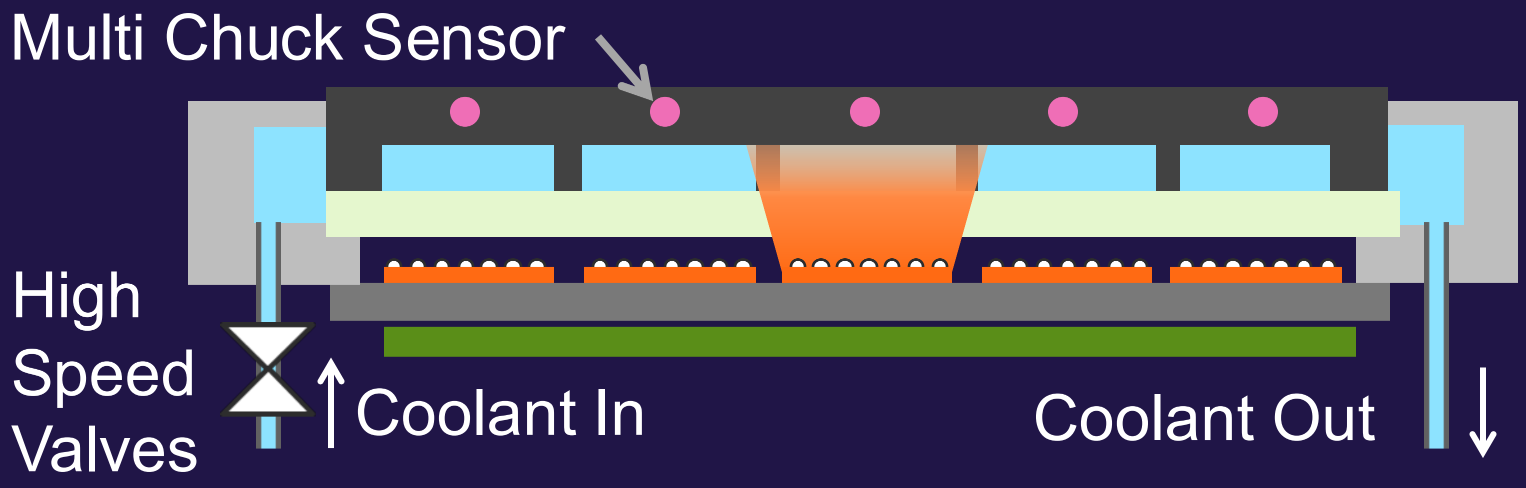
Prober
- <u>**Temp Control**</u>

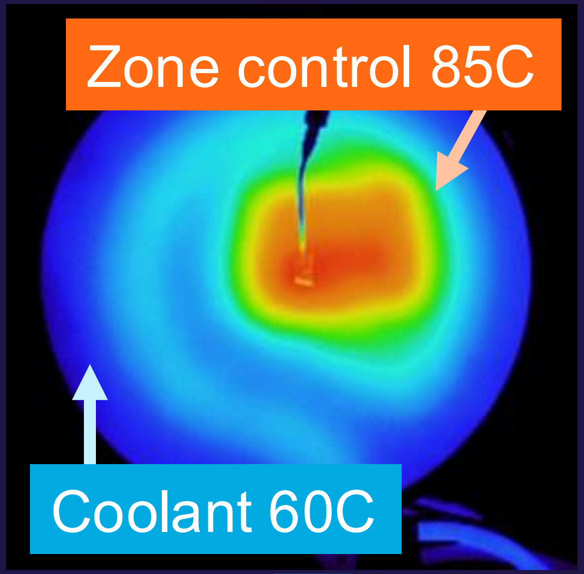
Tester IF Board is Load Board mountable

Tester IF Board sends data from the device to Prober

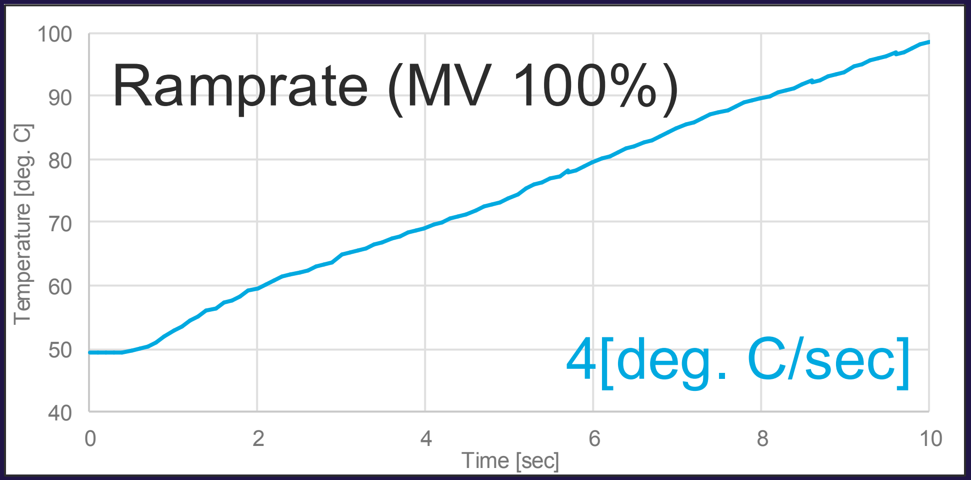
New Technology : Hardware design of Advanced Chuck

- To control the rapid changes Tj





High Cooling Capacity & High Response Time

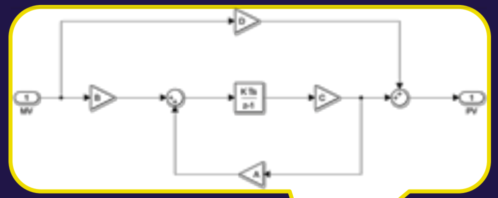


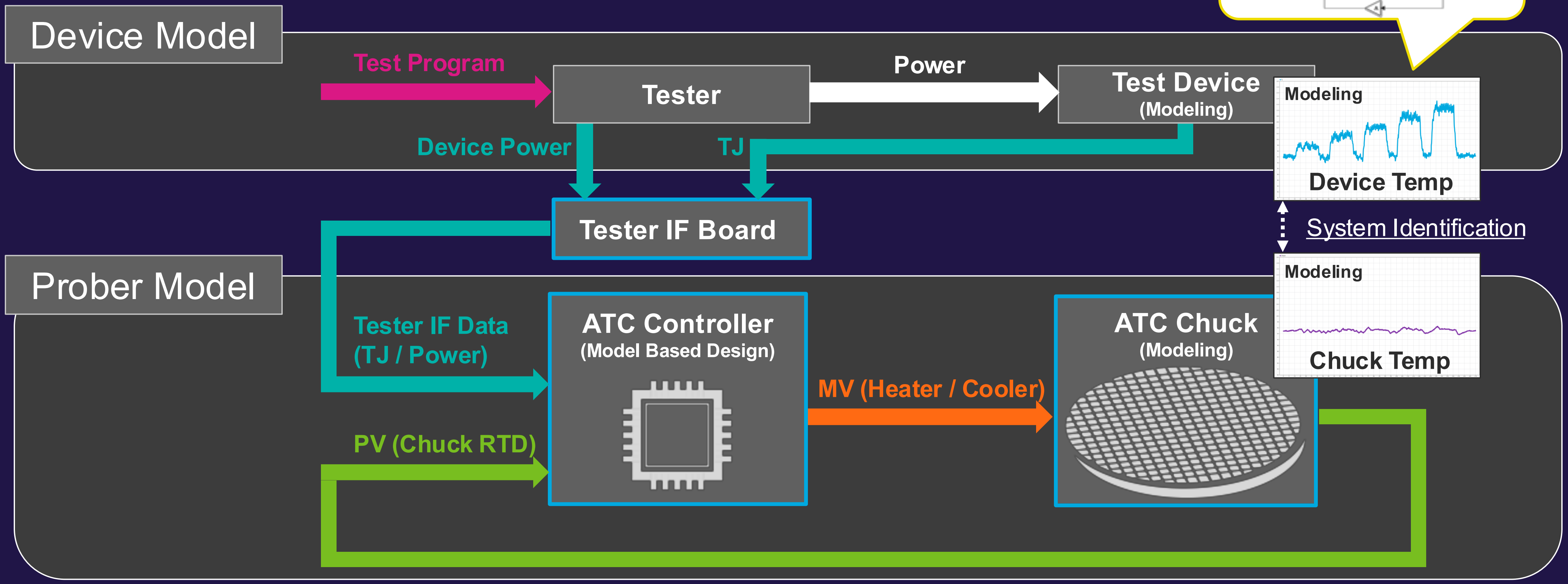
- New heater with Zone control
- Chuck top design with small heat capacity
- Coolant with high thermal conductivity
- High Speed Valves

Development items made possible to High Cooling Capacity & High Response Time

New Technology: Model-based controller design

- Overall system for Heat Dissipation Simulation
  - ➢ Model the chuck and device response as a state space from actual machine data
  - ➢ Controller is model-based design through simulation



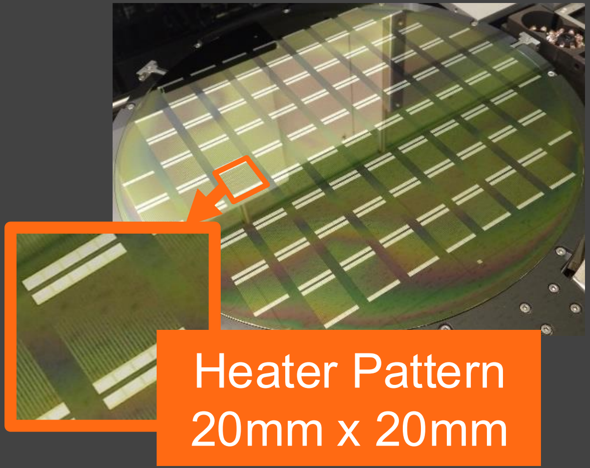


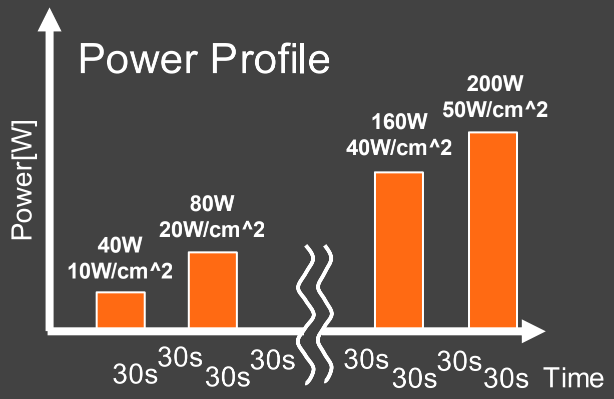
Let's discuss the details in the Key Data section

Key Data : Evaluation Fixture and Thermal Control Mode

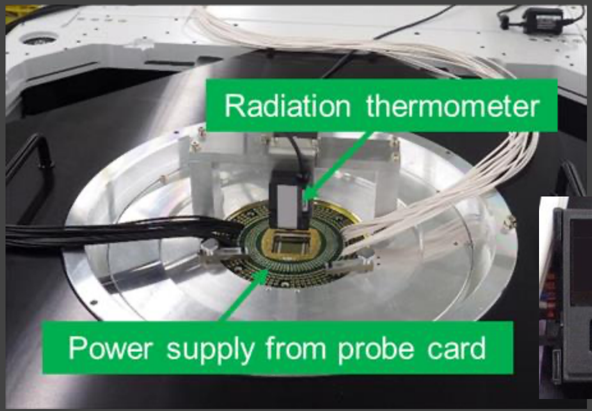
Evaluation Fixture

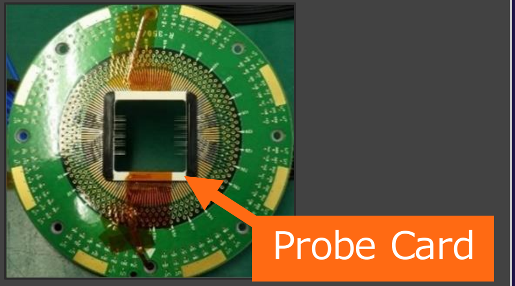
- Heating Device on wafer

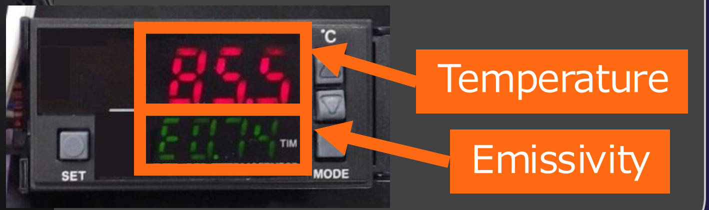




- Measuring Device temp



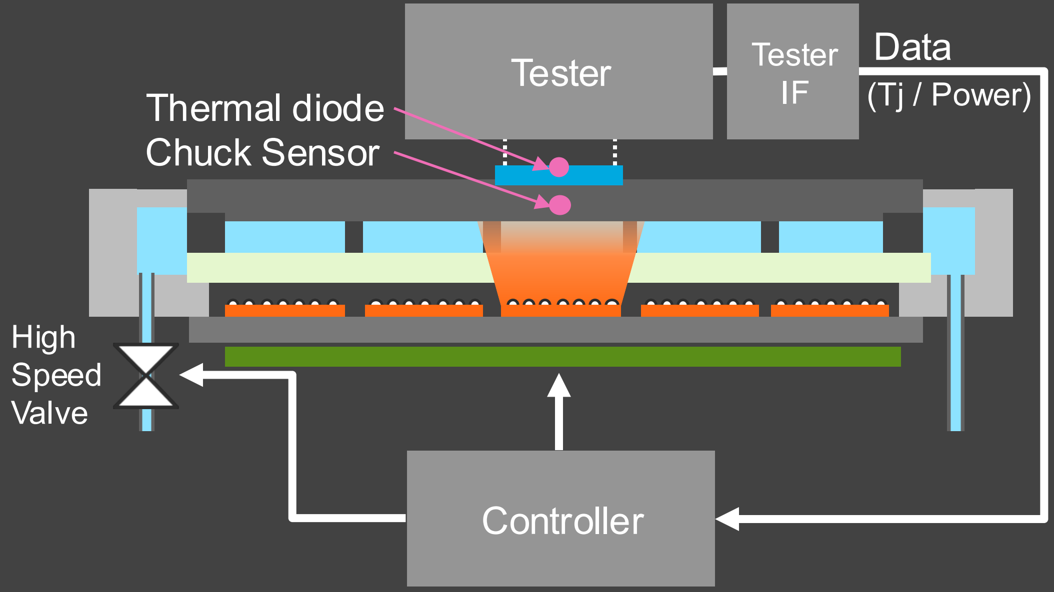




Thermal Control Mode

4 modes are available

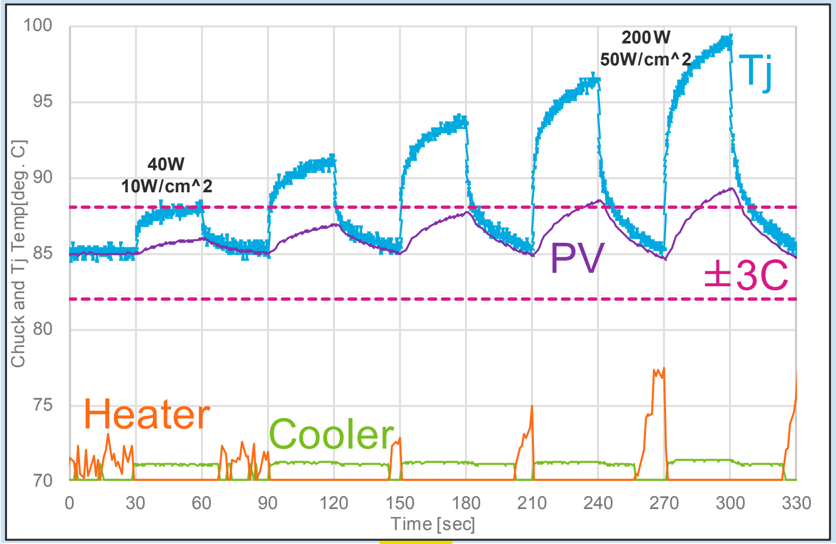
- HTF (Chuck Temp Feedback)
- DTF (Device Temp Feedback)
- PF (Power Following)
- GPIB Offset

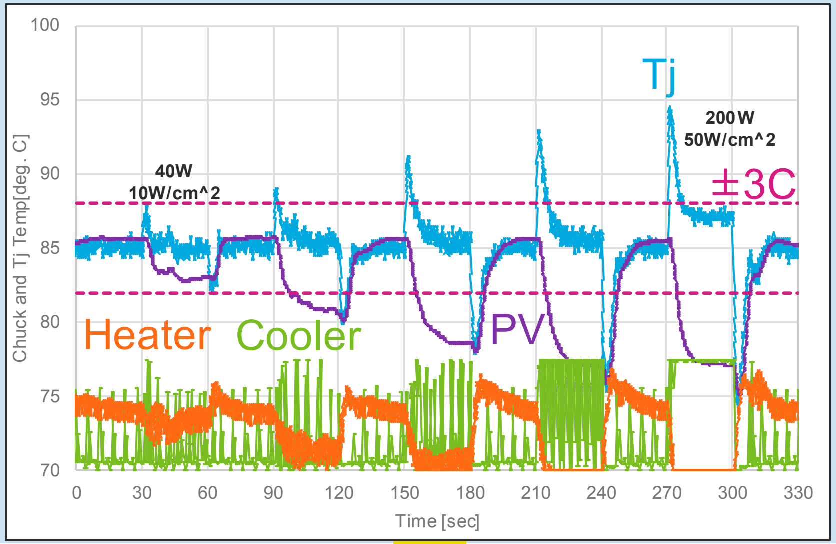


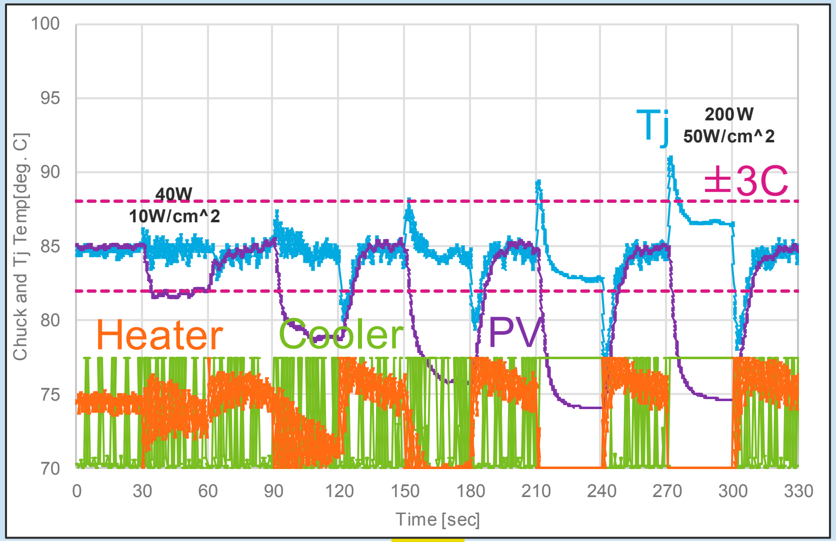
Source: TEL

Key Data : Results in each control mode @85C

Conventional Prober **Chuck Temperature Feedback**	**New Technology (ATCS)** **DTF Mode** (Device Temp Feedback)	**New Technology (ATCS)** **PF Mode** (Power Following)







- Prober controls Chuck PV
- Difficult to cool high heat generating Device
- Device Power below 40W(10W/cm2) and within the guard band(±3C)

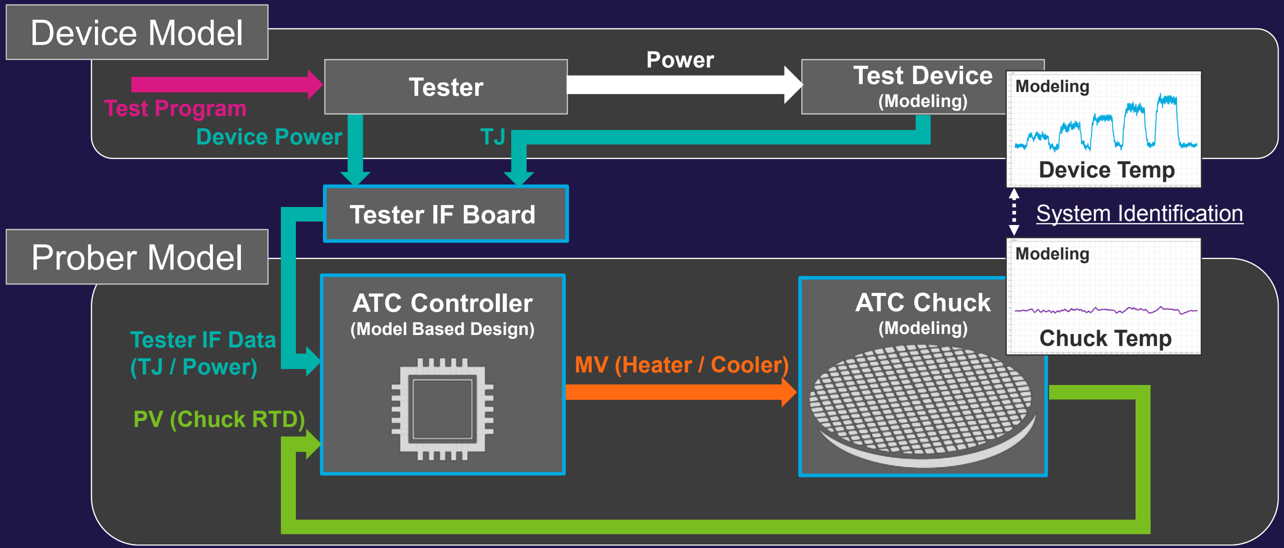
- Chuck PV changes actively to keep Device Temp constant
- Overshoot by time constant $\tau_{Chuck} > \tau_{Wafer}$
- Device Power below 200W(50W/cm2) and within the guard band(±3C)

- Chuck PV is faster than DTF Mode
- Device Power within the guard band range is the same as DTF Mode
- Estimates and controls Tj from power
- Overshoot can be suppressed up to 120W(30W/cm2)

Successful device temperature control by DTF Mode / PF Mode

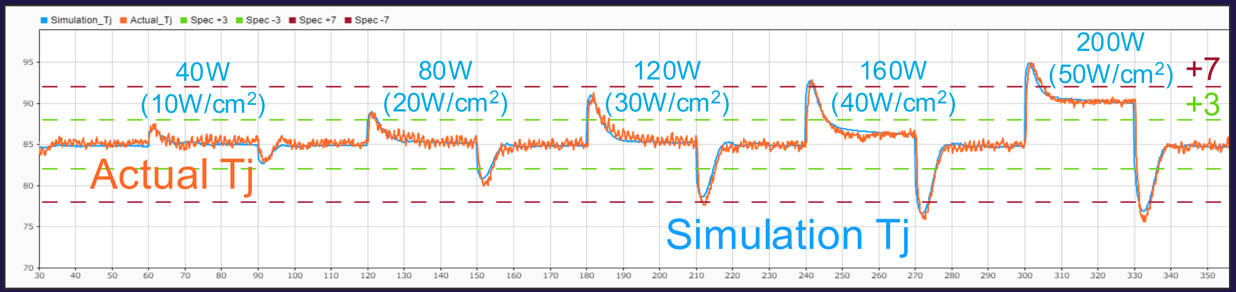
Key Data : Tj Simulation

- Overall system for Heat Dissipation Simulation



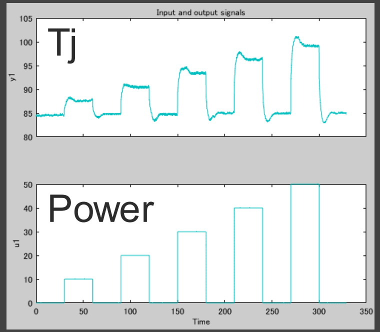
- Actual vs Simulation

Simulation result was quite much with actual data.

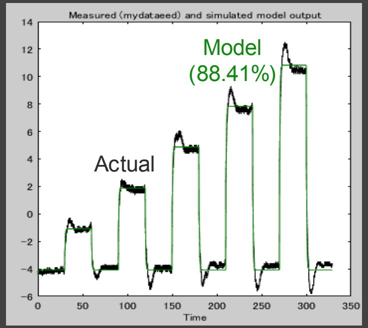


- Creating a device model

➢ Identify the TJ change relative to test power input.



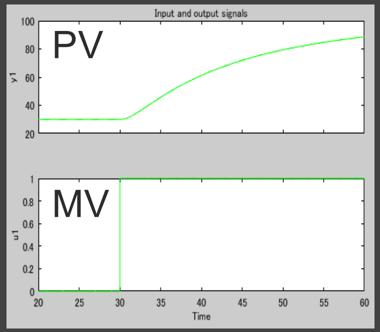
Power/TJ Log



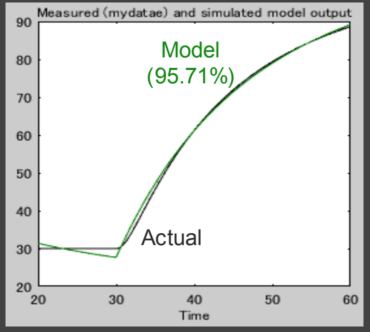
Identification

- Creating a chuck model

➢ Identify the chuck RTD change relative to heater input.



MV/PV Log



Identification

The Prober was developed on a model basis using a simulator

Conclusion

- New Technology enables Device Temperature Control at Wafer Level, and in evaluations, Tj was maintained within ±3C at a power of 50W/cm2

- The following changes were effective for high-heat generating devices

  - Fast response time due to improved thermal capacity of chuck

  - Unique thermal systems and controllers

New Technology enables True KGD verification testing in wafer test , contributing to the future evolution of Logic devices and chiplets

Future Work

- Wide range of temperature
- Increased cooling capacity
- Further Improvement of Response Time

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